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A QFD As Decision Model For Reevaluating Seaport Criteria

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Abstract

Maritime container and cargo shipping are profitable pursuits for shippers and shipping lines associations to transport various cargo types among different seaports and harbors. Locating and selecting the most appropriate ports and routes from several alternatives are referred to be a complicated Multiple Criteria Decision Making (MCDM) issue since it demands multiple factors.

Since the shipping line is integrated with the global supply chain and controlling the port and route choices. The port selection criteria have changed and have become different from traditional selection factors. Thus, the needs for reevaluating the various ports selection criteria to be compatible with the new selection maritime transportation era are being obvious.

Port selection criteria in the shipping route based on the Quality Function Deployment (QFD) concept research findings had changed as a result of, integration management of maritime shipping lines into global supply chains. The most noteworthy determining criterion when shipping lines select the port of call on a single route is, port Geographical Location as a second most significant selection parameter behind port effectiveness and IT ability. The third issue to take into consideration is the port dues and terminal handling charges.

This paper uses quality function deployment (QFD) as an analysis tool to determine the relative weight of top eight port selection criteria (port location, water draft, size of the hinterland, feeder services and intermodal connections, cargo volume, port charges, port efficiency and IT ability). Raw data are collected via distribution of questionnaires to various shipping lines and stakeholders operating in this field. The QFD model results show that Port efficiency and reliability, IT ability and port location are the most important port selection criteria. Port competition and development should consider these changes in port selection criteria.

Key-words:
Quality Function Deployment (QFD) – Port selection criteria - Multicriteria decision making – Task oriented weighting - intelligent decision support

1. INTRODUCTION

The transportation activities have become crucial for most of the globalized container shipping line and shipping companies due to the development in the existing economic sector. Organizations must choose the proper technique to ship and transport their cargo, containers, and merchandises through the proper supply chain partners as the effectiveness of these activities enhances the competitive advantage of organizations, with their huge market share of global trade, maritime shipping and transportation that have recently become one of the most essential industries.

Evaluating the suitability of seaport for a specific task in marine transportation is challenging and complex. The complexity of the evaluation and selection process is due to: (a) the presence of multiple, often conflicting evaluation criteria and their associated sub-criteria (Balmat, et al, 2008), (b) the multidimensional nature of the problem (Wibowo and Deng, 2009), (c) the existence of subjects and uncertainty in the human decision making process (Wibowo and Deng, 2009; Zimmermann, 2000).

The challenge of the selection process and the evaluation comes from the needs for making transparent and consistent decisions in a timely manner and cost crash based on a comprehensive evaluation of sea ports criteria with respect to shipping line perspective (Ang et al, 2007). Many approaches were developed to solve the seaport evaluation and selection problem from different perspectives, these approaches focus on maximizing the profit in selecting and evaluating sea ports criteria considering the uncertainty on the shipping integration factors and the horizontal integration of shipping lines in the global supply chain in the decision making process.

Multi criteria analysis is a decision making tool for complex decision problems. Different from single criterion analysis, multi criteria analysis is able to deal with complicated situations where more than one criterion exists and even their relative importance is not constant (Guy and Urli, 2006). A multiple-criteria decision analysis MCDM tool as the analytic hierarchy process (AHP) and technique for order of preference similarity to ideal solution (TOPSIS) is introduced in evaluating and assessing the seaports criteria. The risks of using these methods are the candidates' different levels of quality, lower response rate and inconsistency. However, these approaches need as a main requirement computational considerable effort due to using integer programming in the port criteria evaluation and selection process (Gabriel et al, 2005).

Han et al, (2001) presented a decision approach based on quallity function deployment (QFD) methodology in the maritime transportation for container ship selection as mainfacture application. The proposed decision model takes into account ship attributes and customer needs in addition the relations between them. Due to this fact the maritime transportation factor that includes the ship characteristics and relationships between company needs are still imprecise and vague, other factors as port selection criteria may have qualitative or quantitative dimensions need to be re-evaluated using smart techniques to develop the MCDM approach.

Hauser and Clausing (1988) presented the changes in shipping line behaviour and global supply chains that affect port selecting criteria and choosing the proper ports in the different shipping routes. However, on the other hand, how could ports react to shipping lines' change and how ports could be developed to be combustible and more competitive under the new situation remains a confusing problem to the world. None of the studies have examined port choice based on intelligent techniques in a situation where a port is considered as an element of a supply chain (Magal, 2004). This research demonstrates a way to re-assess the properties of port selection criteria and reevaluating the impact of shipping line integration in the global supply chain, based on the QFD support decision tool.

Analyic descriptive methdolgy to review previouse work and determine the knowleadge gab. Then it applies the QFD as a MCDM tool to provide general empirical findings of the targeted ports in QFD model and support the research model and outcomes. In so doing, a questionnaire has been designed, include multiple choice questions to allow respondents to select one or more options from a list of answers that was defined and correlation matrixes to collect primary real data and distributed to (98) participants from target shipping line that choose to expand networks through slot charter

agreement, shippers, freight forwarder, Consignees, logistics service providers and port authorities (Ding, 2007). A Likert scale, nine points were employed in the questionnaire design to denote weak, medium and strong relationships between customer needs and port criteria, acquire original data which will be used in a QFD support model is that used as the major method in this research. The results from QFD model will be analyzed through a few basic statistical techniques (average, quartile, etc.). Finally, some analyses based on QFD outcomes will be employed to provide implications, suggestion as well as innovative thoughts for change of selection criteria and port competition.

2. SELECTION AND REFINERY OF CRITERIA

Chang et al (2008) singled out 22 criteria as the most important affective port selection criteria as follows: geographical location, water draft, feeder connection, inland-hinterland connection , scope of hinterland, port reputation, port dues, terminal handling charge (THC), handling speed/efficiency, service reliability, cargo volume, transshipment cargo volume, import and export cargo balance , cargo profitability, berth availability, IT ability, convenience of customs process, relationship between management and workers, acceptance of special requirements ,easiness of communication with staff, calling for competitors, and slot exchange cooperation lines.

The current research finds these criteria in need of reconsideration. The reasons for so doing are as follows. First, some factors are kind of overlapping in terms of meaning, hard to measure and a bit ambiguous. Second, it is not rational to include too many factors in the questionnaire, especially when one considers the time needed to complete it. Finally, the main paper objective is to verify QFD as a decision support model in reevaluating the port selection criteria.

To reduce the number of factors from 22 to 8 , some factors were disregarded (ambiguous) and others were merged together (port dues and terminal handling charge). Thus, the eight criteria to be considered are: geographical location, water's draft, hinterland size, feeder and intermediate connection, cargo volumes, port dues, terminal handling charges (THC), port efficiency, reliability and IT ability.

3. THE (QFD) CONCEPT

QFD is a strategic tool for developing and improving services and products based on consumer needs and requests. It is an organized method of translating customer wants into engineering characteristics of a service or production order to ensure a quality level that fulfils the customer's desires at every stage of manufacturing and service application. QFD is founded on gathering and translating customer requests into specifications and Individual features, process plans, and production and service requirements are then developed.

Figure (1) below shows each of the sections contained in "the House of Quality (HOQ)". Every section holds important data, specific to a part of the QFD analysis. The matrix is usually completed by a specially formed team, who follows the logical sequence suggested by the letters A to F, but the process is flexible and the order in which the HOQ is completed depends on the research team. The house of quality is a qualitative and subjective tool for translating the client's requirements into technical features.

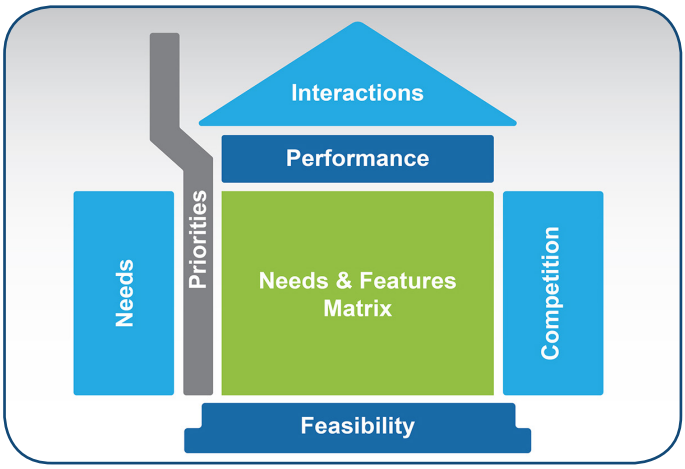

Figure (1): House of quality by Qualica QFD
Source: https://hygger.io/blog/quality-function-deployment-qfd

Each cell and part of the body of HQA in Fig 1 displays the relationship between client needs, and both technical requirements and characteristics (Han, et al, 2001).

4. QFD METHODOLOGY

The QFD approach entails creating matrixes or quality tables. The first integrated matrixes are known as "the House of Quality (HOQ)". Each part contains crucial data

pertaining to a certain aspect of the QFD assessment. There are four phases to a comprehensive QFD:

a. Service Planning: Translate client requirements and establishing the house of quality
b. Service Design: Convert service requirements into essential system service criteria
c. Process Planning: Determine the important process procedures required including and process parameters (or target values) are recorded.
d. Process Control: Include control activities, create control strategies, performance indicator and training programs

5. INTRODUCTION OF QFD AS A SMART APPROACH FOR CRITERIA SELECTION

The approach method for solving the port selection criteria decision making based on QFD is presented in this section. MCDM procedures can be utilized to make an appropriate decision for a port evaluation and selection challenge defined by the existence of many and conflicting decision criteria and the availability of various alternatives.

The goal of companies as shippers, shipping lines, or stockholders in a port selection dilemma is to discover suitable ports to convey their cargo safely, within a reasonable time limit, and at a reasonable cost via a reputable shipping firm.

Customer requirements must be evaluated by the QFD team in accordance with the level of priority of the company's strategic objectives. Then, so as to calculate the weights of each port selection criteria, which is one of the main outputs of the house of quality (Bevilacqua et al, 2006), the correlation relationship between client requirements and port criteria must be determined. The weighted summation of the relationship scores with the prioritized customer requirements determines the importance weight of each port selection criteria.

6. QFD-BASED DECISION MODEL FOR CRITERIA SELECTION

A criteria selection problem is applied to demonstrate the implementation of the suggested QFD-based decision-making approach in this section. The port selection problem in this paper depend on fictitious data for port alternatives. The case in question is to choose among the Mediterranean appropriate ports, which are situated in the heart of a network of trade lanes.

6.1 Importance Weights of Customer Needs

In a port and ship selection problem, the objective of the companies is to find a ship to transport their merchandise safely, within a predetermined time limit, at a lower cost via a reputable shipping company. Thus, user needs which can be used in the QFD process are delivery of cargo in undamaged condition (CN1), timely delivery of cargo (CN2), total cost (CN3), the reputation of the shipping company (CN4) (Gaonkar, 2011).

The firm needs are used to plan the quality home. The QFD team used an integer scale to prioritize the company's needs. The weightings are based on the direct experience of team members with the transportation procedure (Hauser, 1988).

6.2 Interrelation Matrix

The interrelation matrix indicates the link between the customer's needs and the port criterion measures that intended to improve service. The first step in creating an interactive matrix is to get feedback from customers on what they want and need from a particular service. These perspectives are taken from the planning matrix and placed on the interrelationship matrix's left side. The port managements can start formulating a strategy to enhance their service with this customer overview.

Both strengths and weaknesses are then weighed against the company's priorities to determine which aspects require modifying to outperform the competition, which elements require changing to cope with the competition, and which aspects will remain intact. It is important to choose the best combination possible. Recognizing what needs to be improved enables the generation and display of a list of performance measurements across the top of the interrelationship matrix (Han et al, 2001).

6.3 Properties Matrix

The port's criterion weights, that weighted the total relationship scores with the prioritized company needs are one of the most important outputs of the house of quality (Wibowo and Deng, 2012), specific entries are often used in the properties, matrix for recording

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the priorities assigned to requirements. It also shows the competing products' performance as well as the difficulty of developing each criterion.

On the high priority quality characteristics, an organization's existing product can be compared to competitors' service. QFD aids businesses in identifying areas where they may achieve the highest levels of customer satisfaction at the lowest expense. Properties Matrix calculated in Table I by applying the following equation:

- attention of port criteria equals: Σ PC n = VOCx importance * PCx weight
- attention of customer requirements equals: Σ VOCx = Total PC weight * VOCx importance

For example:

PC1 (Geographical Location) = (5×5) 25 + (5×9)45 + (4×7)28 + (5×4)15 = 113

Relative importance CN1 (Delivery of cargo in undamaged) = (5×5 ×6)150 + (5×7×2)70 = 220

6.4 Competitive Matrix:

The competitive assessment matrix makes up a block of rows corresponding to each technical descriptor in the house of quality. After respective factors have been established, the service is evaluated for each factor that addresses VOC. Similar to the customer competitive assessment, the data that are useful in uncovering gaps in judgment are recorded.

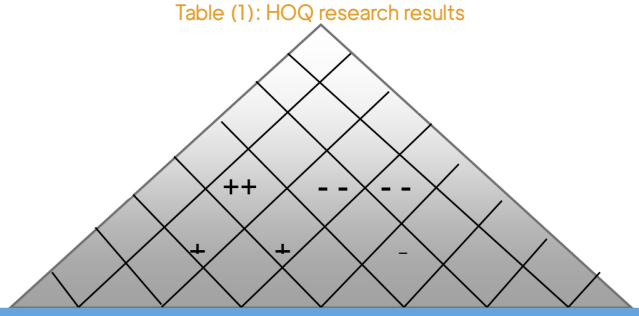
6.5 Port Criteria Correlation (synchronization) Matrix

Existing performance measures are frequently in conflict with one another. The roof, or correlation matrix, is used to aid in the construction of links between customers' requirements and port criteria, and it identifies where these units must function together or they would be in a design conflict. The symbols or numerical value are used to demonstrate the impact of each condition on the others to attract attention to any demands that may be in conflict. Any cell with a high correlation sends a strong signal, that any alterations will require modification.

6.6 Building House of Quality (HOQ) for Port Selection Criteria

The House of Quality is a tool for analyzing customer feedback and is an important part of the QFD process. It all begins with the customer's voice (company needs). It is a tool for converting what consumers demand of services that fit their design principles by establishing a relationship matrix. Table II shows the main structure of HOQ.

Table (1): HOQ research results



		PORT CRITERIA								Total	Total %	Customer survey	Competitor 1	Competitor 2
Company Needs	Importance (priority)	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8					
VOC 1	5	5	5	5	5	5	5	7	7	220	27%			
VOC2	5	9	5	5	7	5	5	7	7	250	30%			
VOC3	4	7	3	5	7	7	9	7	7	208	26%			
VOC4	3	5	3	5	5	5	7	7	7	132	16.3%			
WEIGHTS OF PORT CRITERIA		113	71	85	103	93	107	119	119	810		This part for any future new ports design and as an assessment for existing port W.R.T other ports		
		0.140	0.88	0.104	0.127	0.115	0.132	0.15	0.15					
RELATIVE WEIGHTS		14%	8.8%	10.4%	12.7%	11.5%	13.2%	15%	15%	100%				

*VOC 1 Delivery of cargo in undamaged
VOC 2 Timely delivery of cargo
VOC 3 Total cost
VOC 4 Reputation of the shipping company

PC 1 Geographical location
PC 2 Water draft
PC 3 Hinterland size
PC 4 Feeder and intermodal connection

PC 5 Cargo volumes
PC 6 Port dues and terminal handling charges
PC 7 Port efficiency and reliability
PC 8 IT ability

7. THE EMPIRICAL FINDING OF PORT CRITERIA BASED ON APPLYING QFD

The empirical finding of applying QFD on each Port Criteria importance relative to each customer needs are shown in table I which illustrates that both criteria Port Efficiency and Reliability criteria (PC7) and IT ability criteria (PC8) are ranking as the highest relative to (VOC1), which means that both requirements have the highest importance to the shipping lines reflecting a deep desire to deliver the shipments and cargo in undamaged condition. Also, the table illustrates that Geographical Location (PC1) ranks as the highest relative to the company need, Timely Cargo Delivery (VOC2) which means maritime ports geographical location still has an important role in creating long-term economic growth. Furthermore, QFD results show that Cargo Volumes that include Port dues and terminal handling charges (PC6) rank as the highest relative to (VOC3), which means that this criterion has the highest importance for shipping cost crashing. The empirical finding of applying QFD reflects that Cargo Volumes (PC6), Port Efficiency and Reliability (PC7) and IT ability (PC8) rank the highest relative to (VOC4), which means that port efficiency, reliability and IT ability beside Port dues and terminal handling charges are the most important criteria to improve the ports and shipping lines reputations.

7.1 The Significance of Port's Location

It will be essential to emphasize and spot the importance of port location even in the Mediterranean logistics area. A good port geographic location must be able to provide convenient access to the hinterland for cargo and ships that are connected to the ground transportation network. Sea ports compete for various hinterlands, and a reasonable port geographic location accelerates this access and assists port gain competence from the start. For any ports, geographical expansion will be the solution for the sake of better location Ports.

7.2 A New Perspective on Port Efficiency and Reliability

An old, obsolete knowledge will never lead to develop the marine service and improve the ports competency. Development requires up-to-date knowledge and perspectives. As the first sharing with IT Ability most important criteria for port selection, port efficiency is the factor needed to be re-considered for the sake of continuous development. Traditional opinion on port efficiency, including the loading and unloading speed of containers is defined as cargo handling efficiency. However, as port becomes an essential element of global or regional supply chains network or even a distribution center of a region, port efficiency must be reconsidered as port logistics efficiency to be compatible with the new trends in the maritime industry. Port logistics efficiency is a set of various efficiency indicators measuring and monitoring the supply chain performance.

8. CONCLUSION

The research findings on port selection criteria in the shipping route are based on the QFD concept considering the integration of the shipping lines into global supply chains. The most noteworthy discovering when shipping lines, select ports of call on a single route, port Geographical Location is the second most significant selection parameter, behind only port effectiveness and IT Ability. The third issue to take in consideration is the port dues and terminal handling charges. This conclusion has significant implications for port development and competition such as a focus on intermediate links and new port development concepts like port-centric logistics. Those responses draw a more detailed conclusion of what this research paper is about. First of all, the liner shipping market factor changing as a consequence of its deeper integration into the global supply chain, this changes force the shipping lines to respond to this new challenge by striving themselves to integrate into global supply chains and value chains as to provide end-to-end logistical services (end-to-end, added value, etc.).

Second, it is obvious from the empirical finding of applying QFD that the aforementioned modifications have an impact on port selection criteria for the shipping lines, the four most essential port selection criteria presently, according to the report findings, are port efficiency and reliability, IT abilities, port geographic location, and Port dues and terminal handling charges (THC). It is gaining more interest as a feeder and intermediate connection. Last, the port location still is an important concern in port selection, and freight distribution patterns are linked to

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port location. For all parties associated with supply chain activities, the strength and breadth of intermediate links are critical. It is also essential that the port transforms itself to become more logistics integrated rather than being led by the logistical requirements of shipping lines. However, present port expansion and competition plans fall short of this strategic goal.

9. RECOMMENDATIONS

The current research supports the claim that port selection criteria will change as shipping lines become more involved in and integrated into global supply chains, networks, and it gives a rough notion of what the key and influencing changes are. Nevertheless, the following are the research's significant flaws and further recommendations:

1. If the businesses are unfamiliar with the ports, they will most likely choose the port with the best reputation to mitigate the potential risks. In order many "soft" criteria also need to be overlooked such as port management level, stevedore-management interaction, and reaction to shipping lines' various demands. To acquire a better understanding of the relative weights of port selection factors, the research advises that all influential criteria should be explored closely next time.
2. To improve port logistics activities and value-added procedure more research is required to focus on port logistics effectiveness.
3. QFD's adaptability has been made to be more convenient to integrate with other advanced quality methodologies.
4. Further, researchers should be able use QFD recent software such as Qualica 2000 software.

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